

***Appendix H2***  
***Noise Analysis of Onshore and Offshore***  
***Construction Phase***

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***AVAILABLE ON CD ONLY***



# ***NOISE ANALYSIS OF ONSHORE AND OFFSHORE CONSTRUCTION PHASE***

## **BHP Billiton LNG International Inc Cabrillo Port Project**

**Oxnard and Santa Clarita, California**

**Prepared for:  
BHP Billiton LNG International Inc.**



**Prepared by:  
ENTRIX, Incorporated**



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**NOTE: Revisions are shown in BLUE font**

## **1.0 Introduction**

BHP Billiton (BHPB) is considering construction of a Floating Storage Re-gasification Unit (FSRU) offshore California. The purpose of the tanker-based facility is to receive, store, re-gasify and export liquid natural gas (LNG) to shore. The FSRU is located approximately 20 miles southwest of Oxnard in 870 meters water depth. The regasified LNG will be transported to shore via two new gas transmission pipelines, with landfall close to Oxnard, California. Once onshore, the transmission pipeline will tie into the existing Southern California Gas (SoCal) system. SoCalGas will make onshore pipeline improvements from the interconnection along a pipeline route predominately traversing through agricultural lands to its Center Road station.

Based on optimization studies of several concepts BHPB selected the best components to satisfy specific conditions. The final concepts that were selected for the components keeping the FSRU at site and connecting it to the twin 24" pipelines are:

- i. Mooring Legs – Catenary Mooring Legs
- ii. Anchors – High Holding Power (HHP) Fluke-Type
- iii. Risers – Flexible Steep Wave Risers
- iv. PLEM – Gravity Base

To estimate noise levels of the construction and installation spreads during all phases of the offshore construction of the project an estimate of equipments, vessels, etc., which would be mobilized during offshore construction and installation stage of the project, and the duration of each piece's use has been prepared and is attached in the Appendix. These equipment types are broken down into the various tables included in the text following, according to construction activity.

A brief outline of the FSRU system, subsea components, and the two 24 inch pipelines to the shore is presented in section 2.0, along with description of the onshore component project. The existing environment is discussed in section 3.0, and potential noise impacts from construction activities are described in section 4.0. References are presented in section 5.0.

## 2.0 System Summary

The proposed offshore gas pipeline system for *Cabrillo Port* consists of several components. The offshore gas pipeline system connects to the floating storage and regasification unit (FSRU) and serves as a gas supply link to shore near Oxnard, California. Custody transfer takes place at a receiving station onshore near an existing power producing facility, but the gas is then transported an additional 15 miles to the Center Road Station. The components associated with the installation of the entire mooring system of FSRU and the offshore gas pipeline are listed below, along with the onshore component.

- i) FSRU
- ii) Mooring Legs
- iii) Anchors – High Holding Power (HHP) Fluke-type
- iv) Risers and Umbilical Pipeline End Termination (PLET) / Gravity Base
- v) Pipeline End Manifold (PLEM) – Gravity base
- vi) Offshore Pipelines (2 x 24") with their own two PLET's
- vii) Shore Approach Tie-In (pipeline/HDD tie-in)
- viii) Shore Approach (HDD beach crossing)
- ix) Above-Ground Installation (AGI)
- x) Onshore Component

BHPB plans to install six (6) PLET / Gravity Bases for the four risers and two umbilicals. There is a provision to possibly add two more risers in the future which would require two more PLETs. Both risers and umbilicals continue through the PLETs / gravity bases with a static section laid on the seabed which itself connects to a single Pipeline End Manifold (PLEM). The twin 24 " pipelines terminate near this PLEM with their own PLETs and are connected to the PLEM through two steel inverted-U jumpers. The PLEM serves as the termination and interconnection/manifolding for both risers and pipelines and enables round trip pigging of the twin 24-inch pipelines from and back to the shore.

The twin 24-inch offshore gas pipelines run to a sub-sea tie-in to the shore approach in approximately 40 feet of water depth. The sub-sea tie-in spool connects the offshore gas pipelines to a Horizontal Directional Drill (HDD) shore approach for each pipeline. Once onshore, the HDDs will penetrate the surface and tie-in to an existing SoCal gas transmission system at an Above Ground Installation (AGI).

## **2.1 FSRU**

The FSRU will be new built barge with a displacement of approximately 195,000 DWT. It will receive, store & regasify the LNG and then send out the gas through the risers. This FSRU will be permanently moored with a Single Point Mooring system.

## **2.2 Mooring Legs**

The mooring legs connect the FSRU to the seabed anchors. The nine (9) anchor legs for the FSRU are arranged in three groups of 3 anchor legs each. Anchor leg groups are spaced on a 120-degree increment, with a separation of 5.0 degrees between legs. Each anchor leg consists of 5 segments of chain and wire terminating in a high holding power, fluke-type drag anchor.

## **2.3 Risers, Umbilicals and Jumpers**

The re-gasified natural gas is exported from the FSRU through four (4) flexible risers with an internal diameter of 11 inches. Each riser travels from the FSRU to the seabed where they are connected to a PLET / Gravity Base and then further extend on the seabed towards the PLEM. Two umbilicals are arranged in a similar fashion and provide the control signals to actuate and control the various functions of the PLEM. In addition, provisions have been made to incorporate two (2) additional 11-inch risers in the future. Each riser/umbilical has a total deployed dynamic length between FSRU at the sea surface and its PLET at the seabed of 1,010 meters. The PLET/gravity bases are located at a radius of approximately 170 meters from FSRU turret center. Buoyancy modules are attached to the risers and umbilicals over a length of 90 meters, starting 10 meters above the PLET. The risers and umbilicals then extend statically on the seabed from the PLETs for a length of ~900m and connect directly to the PLEM. The PLEM is located at a radius of approximately 1000m from the FSRU turret center.

The risers and umbilicals will be pre-installed and abandoned on the seabed prior to the arrival of the FSRU. The PLEM may or may not be pre-installed at the time the risers are pre-installed. If not, then the PLEM end of the riser jumper / umbilical will be abandoned. When the FSRU is moored to its mooring legs, the previously abandoned risers or umbilical can be retrieved from the seabed and hooked up to the turret using an anchor handling tug (AHT) or other installation vessel.

## **2.4 PLEM**

The proposed offshore gas pipeline system will connect to the FSRU system at the bottom of the risers on the seabed via a PLEM. The PLEM is a seabed-supported structure used to connect the risers from the FSRU to the pipelines from shore. The PLEM is also used to manifold between the incoming and outgoing lines and to provide options for pigging, shut-in, emergencies, etc. The PLEM is a gravity base structure, meaning it relies on weight for on-bottom stability. This type of PLEM is standard in the industry. The PLEM is estimated to weigh approximately 475 MT. Installation of this PLEM would require a derrick barge or other heavy weight lifting system.

## **2.5 Offshore Pipelines and PLETS**

Two offshore gas pipelines will be used to deliver the natural gas from the FSRU to the AGI. Each pipeline will be installed separately and is expected to have approximately 100 feet of

separation from the other offshore gas pipeline. The proposed route for the offshore gas pipelines is approximately 20 to 21 miles in length. The proposed route transverses from the flat expanse of the Hueneme Fan in approximately 2,850 feet depth, then proceeds up a slope where it parallels the Navy FOCUS cable, then it continues onto the shallow shelf where it approaches Ormond Beach near Oxnard, California. Each offshore gas pipeline terminates into a separate tie-in spool that will connect the offshore gas pipeline to its respective HDD shore approach.

Near the PLEM, the twin 24" pipelines each terminate with their own PLET which is just a stable metal frame mudmat ensuring the pipeline end connection faces upwards. A similar upward looking connection is integrated for each pipeline on the PLEM. Each pipeline connects to the PLEM with a steel 24" inverted U jumper which at its end links into the upward facing connectors.

## ***2.6 Shore Approach Tie-In***

The shore approach tie-in spools will be used to connect the offshore gas pipelines to the HDD shore approaches in approximately 40 feet water depth. Each tie-in spool will consist of an induction bend to adjust the appropriate offshore gas pipeline heading to match that of the respective HDD shore approach. Connections for the tie-in spools to both the offshore gas pipelines and the HDD shore approaches will be either flanged or welded connections.

## ***2.7 Shore Approach***

HDD will be the method used for the shore approaches. Each offshore gas pipeline will have a separate shore approach. The shore approaches will traverse from approximately 40 feet water depth to approximately half a mile inland to an entry point near a power plant. The HDDs will exit into the ocean at a small angle relative to the seabed to avoid the pipeline protruding from the seabed any more than necessary. This is to ensure the safety of vessels in the area and the safety of the pipeline. The HDDs will enter the ground from the AGI at a small angle relative to horizontal in order to provide ease of installation and additional safety at the AGI.

## ***2.8 Above Ground Installation (AGI)***

The AGI will be placed at the entry point of the HDD shore approaches near the power plant onshore. Manifolding and a metering station will make up the AGI.

## ***2.9 Onshore Component***

In order to receive gas from Cabrillo Port, some system improvements would be required by SoCalGas. The Onshore Component of the Project addresses these improvements beginning at the SoCalGas tie-in, where gas will flow into a new approximately 14.3-mile 36" diameter Center Road Pipeline, to be constructed and owned by SoCalGas. The Center Road Pipeline will commence at the metering station with the Cabrillo Port subsea send out pipelines and terminate at the existing SoCalGas Center Road Valve Station. It will be installed in the vicinity of existing Line 324 and would follow existing right of ways, public roads, and/or newly acquired easements. The Center Road pipeline would be located within Oxnard, California, and the County of Ventura. It begins at the Reliant Ormond Beach Generating Station and terminates at the Center Road Valve Station. The pipeline traverses agricultural, residential, commercial and

light industrial areas. An additional Line 225 Loop will be constructed consisting of an approximate 7.7-mile 30-inch diameter pipeline between SoCalGas Quigley Valve Station and the Honor Rancho Storage Field facilities. The route would generally parallel the existing Line 225 pipeline either in or near existing right-of-ways within unpaved portions of the route. Additional appurtenant facilities will be required for the Onshore Component of the Project.

SoCalGas requires the construction of two pipeline segments to receive 800 million cubic feet per day (MMcfd) of natural gas. These pipelines include:

- An approximate 14.3-mile 36-inch diameter pipeline commencing at the new metering station adjacent to Reliant's Ormond Beach Generating Station and terminating at SoCalGas' Center Road Valve Station (the Center Road Pipeline).
- An approximate 7.7-mile 30-inch diameter loop pipeline between SoCalGas' Quigley Valve Station and the Honor Rancho Storage Field (the Line 225 Loop).
- Additional new appurtenant facilities, including metering stations, pig launchers and receivers, control valves and other monitoring facilities.

### **3.0 Existing Environment**

#### **3.1 *Existing Noise Levels***

Cabrillo Port will be located near the Point Mugu Sea Range. In their Final Environmental Impact Statement (U.S. Department of Navy 2002) the U.S. Navy characterized this area's average baseline noise levels at 50-55 decibels (dB) for the area designated "3A" and "3D" (See Figure 3.3-1, NAWCWPNS, 2002). This area encompasses an area that is bordered by Anacapa Island, the south side of Santa Cruz Island to San Nicholas Island and Santa Barbara Island, and would be indicative of the noise level in the Project area.

#### **3.2 *Background Noise Levels in the Ocean***

Naturally occurring noise levels in the ocean from wind and wave activity may range from 90 db re 1  $\mu$ PA under very calm, low wind conditions to 110 dB re 1  $\mu$ PA under windy conditions (Woodside 2002). Wind is the major contributor to noise between 100 Hz – 30kHz, while wave generated noise is a significant contribution in the infrasonic range (1-20 Hz). Surf noise, however, is specific to coastal locations (Simmonds et al. 2003). (Refer to Section 4.1 for an explanation of underwater acoustics.)

#### **3.3 *Sources of Human Noise Within Project Area***

##### **3.3.1 Production rigs**

There are four oil and gas production rigs located offshore of Ventura County – Platforms Gina, Gilda, Gail and Grace. All are currently in production, except for Platform Grace, which is no longer producing but moves product from Platform Gail to the Carpinteria Gas Plant in Santa Barbara County.

Richardson, et al. (1995) is frequently cited regarding noise impacts on marine mammals (Woodside 2002; DTI 2004; Pidcock 2003). According to Richardson et al, there are very few data on noises associated with production activities, but the noise produced by rigs are comparable to those produced by semi-submersible drill rigs. Drill rigs are generally lower than drill ships or caisson rigs where some machinery is below the waterline. In a recent study, noise from a semi-submersible drilling rig and its support vessels working in 114 m waters in the Bering Sea did not exceed ambient noise levels beyond a 1-km range (Sakhalin 2004). Broadband underwater noise from a drilling rig in the Timor Sea were measured at 146 dB re 1 uPA when not actively drilling, and 169 dB re 1 uPA during drilling. The noise dropped steadily and was not audible beyond 11 km from the rig under quiet ambient conditions (Woodside 2002; Pidcock et al. 2003). Other rigs were recorded at 154 dB re 1uPA for the frequency band 10-500 Hz (Woodside 2002).

##### **3.3.2 Marine Vessel Traffic**

Noise from ships dominates marine waters and emanates from ships' propellers, machinery, hulls passage through water, and use of sonar and depth sounders. Most shipping has a low frequency range of less than 1kHz that coincides with the frequencies

used by baleen whales. Typically, shipping produces frequencies below 1 kHz, small leisure craft generate sound from 1 kHz to 50 kHz. Quieter, faster boats cause more disturbance than slower larger boats, because they tend to provoke a “startle” reaction (Simmonds et al. 2003).

Generally, the ambient noise spectral level in the ocean is about 140 dB re 1  $\mu$ PA squared per Hz at 1 Hz and decreases at the rate of 5 to 10 dB per octave to a level of about 20 dB re 1  $\mu$ PA squared per Hz at 100 kHz. Vessels are the greatest contributor to overall noise in the sea. Ambient noise level due to ship traffic may be nominally 75 dB re 1  $\mu$ PA squared per Hz at 100 Hz, the source level associated with a large tanker is actual 186 dB re 1  $\mu$ PA per Hz at 1 m (Gisiner 1998). Other sources cite shipping traffic at frequencies from 20 to 300 Hz, with fishing vessels producing the higher frequency sound peaking at 300 Hz, and larger cargo vessels at the lower frequency sounds. (MMS 2001b). MMS continues with estimated source levels of 156 dB for a 16-m crew boat (with a 90-Hz dominant tone) and 159 dB for a 34-m twin diesel (630 Hz, 1/3 octave). Broadband source levels for small, supply boat-sized ships (55-85 m) are about 170-180 dB. Most of the sound energy produced by these vessels is at frequencies below 500 Hz (including many of the commercial fishing vessels operating off southern California) (MMS 2001b). Support vessels to the drill rig were recorded at average noise levels of approximately 182 dB re 1 $\mu$ PA, noise produced mainly by the bow thrusters (Pidcock et al 2003).

Large vessels tend to be noisier than small ones, as are vessels with a full load (towing or pushing a load) than unladen vessels (Pidcock et al 2003; Simmonds et al. 2003). Noise also increases with vessel speed. In a study of whale watching vessels in Hervey Bay in Queensland, Australia the primary predictor of underwater noise for small vessels was found to be its speed (Pidcock et al. 2003). Propellers produce most of the broadband noise, with propulsion and auxiliary machine contributing a significant noise (Pidcock et al. 2003; Sakhalin 2004). In another study underwater noise from a 20-m fishing vessel traveling at 11-12 knots in the Timor Sea was recorded at 166 dB re 1 $\mu$ PA, and a 64-m oil rig tender at 177 dB re 1 $\mu$ PA, indicating that the larger the boat the more noise it produces (Pidcock et al. 2003).

While working, support vessel maintain position during loading and unloading supplies, conducting installation activities, using strong forward and reverse thrusts from the engines and bow thrusters (Woodside 2002). The broadband noise of a rig support vessel in the Timor Sea was measured underwater at about 182 dB re 1 $\mu$ PA, compared to a reported level of 170 dB re 1 $\mu$ PA from a whale watching catamarans (Woodside Energy Ltd). Noise from support vessel holding its position using bow thrusters may be detectable above background noise during calm weather for 20 km or more from the vessel (Woodside 2002).

Distant shipping noise causes elevated sea noise across a defined frequency band (5-100 Hz), whereas nearby shipping is readily discernable as a ship. For a merchant vessel underway, propeller noise dominates the total noise field. A model developed by the Centre for Marine Science and Technology at Curtin University indicated a noise spectrum for a 173 m bulk carrier traveling at 10 knots to be between 3.5-100 Hz (Pidcock et al. 2003).

Construction of the Project will utilize a pipe-laying vessels with a thruster system to maintain position (dynamic positioning vessel), high sound energy may be produced

which could cause reactions by whales as far as several kilometers away. Noise associated with pipe handling and the vessels' turbine generators are not specifically known and are difficult to estimate (Sakhalin 2004). When the pipe-laying vessel is resupplied with pipe from another supply vessel (with bow thrusters) sound levels could be 177 dB re 1 uPA rms (Sakhalin 2004; DTI 2004). Continuous broadband sounds will transmit through the vessel's hull from the gas turbines power the pipe welding stations and pipeline movement (Sakhalin 2004).

Refer to Table 3.3-1 for a Summary of sound frequencies produced by shipping traffic and their source levels. Refer to Table 3.3-2 for a Summary of noises produced during oil and gas exploration activities. This table includes marine vessels underway, drillships, rigs, platforms, aircraft and pile driving, and gives reference noise levels for typical equipment in the oil and gas industry. Vessel ratings from these tables were used for the reference dB of construction equipment specified in Section 4.0.

### **3.4 Literature Review of Impacts of Noise to Marine Life**

#### **3.4.1 Marine Mammals**

Marine mammals rely heavily on the use of underwater sounds to communicate and gain information about their surroundings. It's assumed they can hear many anthropogenic sounds, some of which may have negative effects. Since underwater noise can propagate for long distances, the radius of audibility can be large for strong noises. However, it appears that marine mammals usually do not react overtly to audible, but weak, anthropogenic sounds; thus the radius of responsiveness is much smaller than the radius of audibility (U.S. Department of Navy 2000).

Audiograms for several dolphin species indicate hearing thresholds of 120-140 db at 100 Hz (UK DTI 2004). For continuous noise, whales begin to avoid sounds at exposures levels of 110 dB and more than 80 percent of species observed show avoidance to 130 dB (Pidcock 2003). Whales, dolphins and porpoises spend all their time in the marine environment while pinnipeds live in both water and on land. Airborne noise is also a concern to pinnipeds during their haul-outs onto land, and also to some species of whales (Pidcock 2003). Masking, or interference with the ability to detect other sounds, was proposed for marine mammals, by Richardson et al. 1995 (as cited in UK DTI 2004), although Richardson et al. indicated that the significance of such effects should be speculative. Masking is a natural phenomenon to which marine mammals must be adapted, with physiological systems and behavior that reduce the impacts. These measures may include the use of high frequency; structured signals such as click sequences in dolphins. Data demonstrating adaptations for reducing masking pertain mainly to the odontocetes (dolphins, porpoises and toothed whales). Nevertheless, high levels of anthropogenic noise may mask communication by some marine mammals (UK DTI 2004).

The U.S. Navy states that strong and/or prolonged disturbance is considered to have potentially adverse effects on individual animals, which in rare cases could be significant to marine mammal populations if they could result in reductions in their populations. Specifically, this would include: a) displacement of pinnipeds from beaches involving potential injury of pups and separation from their mothers; b) activities that exclude mammals from feeding, breeding, or nursing areas for a period of several days or longer;

c) alert or startle reactions of extended interruption of prior activities, or those that are accompanied by other indicators of more severe disturbance; or d) transient sound that is high enough to cause permanent hearing impairment, or causes frequent exposure that because significant, or creates even a single exposure to a threatened or endangered species (U.S. Department of Navy 2000).

The U.S. Navy determined that based on literature review, pinnipeds generally tolerate exposure to high sound levels, especially when motivated to remain in the area to feed. Further, it was apparent from the literature that pinnipeds and toothed whales exposed to prolonged or repeated underwater sounds were not likely to be displaced unless the overall received level is at least 140 dB re 1  $\mu$ PA. The criterion of disturbance for sperm whales and baleen whales appears to be 120 dB re 1  $\mu$ PA. The U.S. Navy also noted that the apparent avoidance threshold for gray whales exposed to repeated pulses of seismic sound was near 156 dB re 1  $\mu$ PA (U.S. Department of Navy 2000).

The U.S. Navy indicated in their study that additional ships in the Sea Range produce sufficient underwater noise to cause short-term changes in baleen whale and sperm whale behavior, and localized displacement of these whales if ships approach them. Reactions are most pronounced if ships are moving rapidly and either directly toward the whales or with variable course and speed. Whales may react to multiple vessels working in the same area at longer distances than they would react to a single vessel. However, bowhead whales displaced from a feeding area returned and resumed feeding within one day. Baleen and sperm whales often show little reaction to ships or boats if the vessel is moving slowly at constant speed on a constant course. Commercial vessels spend a minority of their time traveling at high speed and on variable course and don't normally continue to operate at the same location for longer than time required to transit through the area. In the Sea Range FEIS, it was found that whales in vicinity of San Nicolas Island may be displaced temporarily by approaching vessels but are not likely to be deterred for more than 1-2 days. Disturbance of baleen or sperm whales is temporary and not considered biologically significant. Cumulative impacts of disturbances to baleen and sperm whales by commercial and Navy marine vessels operating on the Sea Range would be less than significant. (U.S. Department of Navy 2002).

Migrating gray whales have been observed to avoid the approach of vessels to within 200-300 m, or even within 350-550 m. Consequently, noise effects on gray whales from vessels can be expected to be limited to within 200-500 m of approaching vessels and to be sublethal and temporary (Arthur D. Little, Inc. 2002)

Data on pinnipeds suggest that they show considerable tolerance of vessels (U.S. Department of Navy 2002). Seal lions in the water often tolerate close and frequent approaches by vessels, especially fishing vessels. Harbor seals often move into the water in response to boats. Small boats within 100 m displace harbor seals from haul out areas and less severe disturbance can cause alert reactions without departure (Arthur D. Little, Inc. 2002). Sea otters may move away when a vessel approaches, but often allow close approaches by small boats, although they tend to avoid high activity areas (Arthur D. Little, Inc. 2002). Baleen whales seem to ignore low-levels sounds from distant or stationary vessels, whereas Minke whales and toothed whales may even approach the sources. However, gray and bowhead whales show some avoidance of areas where repeated noises exceeding 160-170 dB re 1  $\mu$ PA (U.S. Department of Navy 2002).

As a combined group, marine mammals have functional hearing ranges of 10 hertz (Hz) to 200 kHz (NRC 2003). Most impacts to marine mammals from noise are observed behaviorally in the individual (Gisiner 1998).

Malme et al. (1984) concluded that a 0.5 probability of avoidance occurred when continuous underwater noise levels exceeded 120 dB re 1 $\mu$ Pa and when intermittent noise levels exceeded 170 dB re 1 $\mu$ Pa. A 120 dB re 1  $\mu$ Pa criterion has been informally used to identify the level above which acoustic effects on marine mammals might occur (NRC 1994). However, the frequency spectrum, temporal pattern of the sound and auditory sensitivity of each marine species should be considered when applying the criterion (NRC 1994). For example, pinnipeds may be more likely to experience a threshold shift (loss of sensitivity) than cetaceans given that pinnipeds can hear both in air and water, while cetaceans cannot (Gisiner 1998).

### **3.4.2 Impacts of Noise to Fish**

Studies indicate that fish avoid approaching vessels to some degree, usually by swimming down or horizontally away from the vessel's path (Woodside 2002). The degree of observed effect weakens with depth, with fish below 200 m being only mildly affected temporarily, with normal schooling patterns resuming shortly after the noise passes. Further, the clear and abundant presence of surface to mid-water dwelling fish adjacent to operating facilities indicates that they habituate to these noise with no apparent detriment (Woodside 2002).

### **3.4.3 Impacts from Pipeline Operations**

Offshore drilling and production noise levels were cited in several sources as not very intense and generally occurring at very low frequencies, near 5 Hz (MMS 2001a; MMS 2003). MMS (2001a) stated that noises associated with offshore oil and gas production are generally weak and are typically at very low frequencies (about 4.5 to 38 Hz), compared to ship traffic and industrial activity between 10 Hz-10kHz (Gisiner 1998). Sources did not mention pipeline noise particularly, but referred to noises produced by drilling and production platforms off California. Noises produced were so weak that they were nearly undetectable even alongside the platform (MMS 2001b). No source levels were computed, but the strongest received tones were very low frequency, about 5 Hz, at 119 - 127 dB re 1 microPascal. The highest frequencies recorded were at about 1.2 kHz. MMS (2001b) cited Richardson et al 1995 who predicted that the radii of audibility for baleen whales for production platform noise would be about 2.5 kilometers (km) (1.3 nautical miles, nm) in nearshore waters and 2km (1 nm) near the shelfbreak. Richardson also predicted similar radii of response for baleen whales (at less than 100 meters, m), odontocetes and pinnipeds (MMS 2001b, MMS 2003).

**Table 3.3-1. Summary of sound frequencies produced by shipping traffic and their source levels.**

Type of vessel	Frequency (kHz)	Source level (dB re 1uPa)	Reference*
Rigid inflatable (rescue craft)	6.3	152	Malme et al. 1989
7m outboard motor boat	0.63	156	Malme et al. 1989
Fishing boat	0.25-1.0	151	Greene 1985
Fishing trawler	0.1	158	Malme et al. 1989
Tug pulling empty barge	0.037 1.0 5.0	166 164 145	Buck & Chalfant 1972; Miles et al. 1989
Tug pulling loaded barge	1.0 5.0	170 161	Miles et al. 1989
34m (twin diesel engine) workboat	0.63	159	Malme et al. 1989
Tanker (135m)	0.43	169	Buck & Chalfant 1972
Tanker (179m)	0.06	180	Ross 1976
Supertanker (266m)	0.008	187	Thilele and Odengaard 1983
Containership (219m)	0.033	181	Buck & Chalfant 1972
Containership (274m)	0.008	181	Ross 1975
Frieghter (135m)	0.041	172	Thilele & Odengaard 1983

Source: Simmonds et al, 2003, Table 3.2, p. 25

\*Full references are provided in the source document.

**Table 3.3-2. Summary of noises produced during oil and gas exploration activities.**

Noise sources	Source levels, dB re 1 uPa-m							Highest level				
	Broadband	1/3 <sup>rd</sup> octave band center frequencies (kHz)						1/3 <sup>rd</sup> octave band				
	(0.045-7.07 kHz)	0.05	0.1	0.2	0.5	1	2	Freq.	Level	Strong infrasonics?	Freq. Range (kHz)	Dom. Freq. (kHz)
VESSELS UNDERWAY												
Tugs & Barge (18 km/h)	171	143	157	157	161	156	157	630	162	Yes		
5-m Zodiac (rescue craft)	156	128	124	148	132	132	138	6300	152	No		
Supply ship (AHTS)	181	162	174	170	166	164	159	100	174	Yes		
Large tanker	186	174	177	176	172	169	166	100 & 125	177	Yes		
DRILLSHIPS, RIGS, PLATFORMS												
Drillship (45-1780 Hz)	185	174	172	176	176	168	-	400	177	No?		
Drillship	174	162	162	161	162	156	148	63	167	No		
Jack up rig during drilling	59	55.9	54	55.6	469	0	0	16	62.5	-	0.005-1.2	
Semi-submersible											0.016-0.20	
Drilling production												0.25
DREDGING (45-890 Hz)												
AIRCRAFT												
Helicopter flyover @ 305m	108	97	94	97	97	91	88	25	98			
Helicopter fly over (Bell 212)	162	154	155	151	145	142	142	16	159	Yes		
Helicopter takeoff (Super Puma)	-	112	96	85	88	88	85	20	109			
Helicopter flyover @ 305m (Super Puma)	-	98	96	85	88	88	85	20	109			
PILE DRIVING On Scotian Shelf	165	134	145	158	154	141	136	250	159	Yes		

Source: Simmonds et al. 2003

## 4.0 Construction Noise Impacts

### 4.1 Offshore Impacts

During the construction phase of the two pipelines including the shore approaches noise level would vary depending on the type of construction equipment deployed. Noise impacts were evaluated for both ambient noise in air, and underwater noise. Moreover, the construction spreads for the offshore project are:

- Offshore marine spread for the pipelines
- Onshore drilling spread for HDD works
- Offshore marine spread for the FSRU, the mooring system, riser system, etc
- Helicopters and supply vessels for logistics support

The noise impacts from construction of the onshore component are discussed separately below, as impacts relative to ambient noise only.

In the attached schedule of activities, located in the Appendix, all equipment has been identified which are potential source of offshore and nearshore noise. Based on the collected data of noise level for the listed equipment maximum noise, which could occur on a particular day, can be evaluated from the starting day of the construction activities of the pipelines in the near shore and offshore areas. The following assumptions are applicable for the offshore and nearshore construction activities:

- i) There would be two separate marine spreads for the entire project. One marine spread would be for the offshore pipelines and the shore approach area and the other marine spread would be for the offshore FSRU and its associated activities.

Helicopter usage has been shown on a daily basis, although the helicopter would be used for certain period of the day or certain days only. This provides the additional factor of noise, which is to be taken into account for the entire duration of construction.

- ii) Separate helicopters have been considered for the two separate construction activities. In a similar manner supply vessel and tugs have also been considered for separate construction activities of pipelines and FSRU.
- iii) If the installation sequence is altered from the one shown in the schedule of activities, the level of noise would also need to be altered. The most likely installation sequence has been taken into account for the pipeline and FSRU project.
- iv) Commissioning of FSRU at site has not been taken into account. However, hydro testing & dewatering of the pipelines have been considered in the overall schedule.
- v) The zero date of the project has been considered as 7/6/04 but is relatively arbitrary at this stage. Actual dates would be dependent on the date of award of the respective contracts.

Noise level would vary with the time frame of installation schedule. The contributing factors to the noise level in the shore areas would be the equipments and marine spreads of near shore activities including helicopter movements and other local sources. The proximity of the vessels in the offshore activities may not be of much of significance except at the offshore location near the FSRU location, where two separate spreads may have to work next to each other (One for Pipelines and the other for FSRU – Risers/Jumpers/PLET/PLEM).

The underwater noise impacts from construction discussed in this section were calculated based upon the methodology of underwater acoustics from the National Oceanic and Atmospheric Administration (NOAA 2002; NOAA 2004), as discussed below.

### Underwater Acoustics

Sound pressure is sound force per unit area, measured in micropascals ( $\mu\text{PA}$ ), where 1 Pa is the pressure resulting from a force of one newton exerted over an area of one square meter. The instantaneous pressure that a vibrating object exerts on an area is directly proportional to the vibrating object's velocity and the acoustic impedance (NOAA 2004).

A sound's acoustic intensity is defined as the acoustical power per unit area in the direction of propagation, based upon the density of water and the speed of sound. The sound levels to which most mammals are sensitive extend over many orders of magnitude, making it convenient to use a logarithmic scale when measuring sound. Both Sound Pressure Level (SPL) and Sound Intensity Level (SIL) are measured in dB and are usually expressed as ratios of a measured and a reference level. Because the dB scale is relative, reference levels must be included with the dB values to be meaningful. The commonly used reference pressure level in underwater acoustics is 1  $\mu\text{PA}$ , while the reference level in air is 20  $\mu\text{PA}$  (roughly the human hearing threshold at 1000 Hz) (NOAA 2004).

Given these two reference levels, the conversion factor for air to water is:

$$20 \log (p_{\text{water}}/p_{\text{air}}) = 20 \log (20 \mu\text{PA}/1\mu\text{PA}) = + 26 \text{ dB}$$

The characteristic impedance of water is about 3600 times that of air, so the conversion factor for the intensity of sounds of equal pressure in air vs. water is 36 db:

$$10 \log (3600) = 36 \text{ dB}$$

If the different reference pressures (1  $\mu\text{PA}$  and 20  $\mu\text{PA}$ ) are taken into account, the difference is:

$$36 \text{ dB} + 26 \text{ dB} = 62 \text{ dB}$$

(NOAA 2004).

Potential noise impacts from the construction spreads for the offshore component of the project are discussed below; onshore components are discussed in Section 4.2.

#### 4.1.1 Offshore marine spread for the Pipelines

Table 4.1-1 shows the planned equipment types for the construction activity of the offshore marine spread for the pipelines and their associated reference dB (ref. 1  $\mu$ PA), the estimated number of devices to be used, and the estimated average engine load. Helicopter flyover is calculated at minimum altitude, where impacts underwater would be the greatest. Estimated underwater noise level in dB is shown at intervals of 1 meter to 10 km, from the reference noise level cited in the literature, and by calculating the sound pressure levels at each specified distance. Estimated worst case results at each distance were tabulated based upon inverse distance and root mean square calculations as described below.

For underwater sound, the decibel scale is defined as:

$$\text{dB} = 10 \log (P_d^2/P_o^2) = 20 \log (P_d/P_o)$$

where: dB = noise level, decibels

$P_d$  = sound pressure measured or sensed at distance d,  $\text{N/m}^2$

$P_o$  = referenced sound pressure in water,  $1 \times 10^{-6} \text{ N/m}^2$  (1  $\mu$ PA)

In deep water (>200 meters), the sound pressure is inversely proportional the distance d from the source (Inverse Distance Law):

$$P_d = (\text{constant}) (D_d/D_o)^{-1} = (\text{constant}) (D_o / D_d)$$

where:  $P_d$  = sound pressure measured or sensed at distance d,  $\text{N/m}^2$

$D_d$  = receiver distance from source, meters

$D_o$  = reference distance from source, 1 meter

Noise reductions following the Inverse Distance Law demonstrate about a 20 dB falloff with each order-of-magnitude increase in distance from the source, as shown in Table 4.1-1.

Sound pressure from multiple sources in one location or sources operating as less than rated power follow the root mean square (RMS) relationship (square root of the sum of squares):

$$\text{Total } P = (P_1^2 + P_2^2 + P_3^2 + P_4^2 + \dots + P_n)^{0.5}$$

where:  $P_n$  = sound pressure from source  $n$  at reference distance  $D_0$

$n$  = number of sources

Under the RMS relationship, two identical sound pressure sources operating at the same location produce about 1.4 times the sound energy of a single source. Conversely, a sound pressure source operating at 50% of rated load produces about 0.7 times the sound energy of full load operation. This method is used to account for equipment quantities and loads shown in Table 4.1-1. At the source, the noise level is calculated to be 180 dBA ref 1 upa, decreasing to 120 dBA ref 1upa at 1 km.

#### **4.1.2 Offshore marine spread for the FSRU, mooring and riser systems**

Table 4.1-4 shows the planned equipment types for the offshore FSRU, mooring and riser construction/installation activity and their associated reference dB (ref. 1  $\mu$ PA), the estimated number of devices to be used, and the estimated average engine load. Helicopter flyover is calculated at minimum altitude, where impacts underwater would be the greatest. Estimated underwater noise level in dB is shown at intervals of 1 meter to 10 km, estimated from the reference noise level cited in the literature, and by calculating the sound pressure levels at each specified distance. Estimated worst case results at each distance were tabulated based upon inverse distance and root mean square calculations as described in Section 4.1.1 above. At the source, the noise level is calculated to be 180 dBA ref 1 upa, decreasing to 120 dBA ref 1upa at 1 km.

#### **4.1.3 Helicopters and supply vessels for logistics support**

Table 4.1-5 indicates the marine noise from helicopters and marine vessels used for logistics support. Helicopter flyover is calculated at minimum altitude, where impacts underwater would be the greatest. Estimated underwater noise level in dB ref 1  $\mu$ PA is shown at intervals of 50 feet to 2500 feet, estimated from the reference noise level cited in the literature, and by calculating the sound pressure levels at each specified distance.

#### **4.1.4 Impact Summary for Offshore Noise**

The offshore noise levels are below the criterion of 120 dBA ref 1uPa at 1 kilometer from the source. Outside this zone no impacts to marine mammals would occur. Within this zone, the noise levels are similar to existing levels for shipping and drilling. These values may produce short-term avoidance behavior, but no long-term, biologically-significant responses are anticipated. No pinniped haul-out areas are close enough to be affected. Therefore, the impacts to marine mammals and fish from construction and operational noise will be less than significant. The following mitigation has been proposed for physical hazards to marine mammals, and is repeated here as further protection from any noise-related concerns.

#### **4.1.5 Minimization and Mitigation Measures**

The applicant will consult with NOAA Fisheries, USFWS and CDFG to discuss minimization and mitigation measures. This report proposes avoidance of construction when marine mammals are within a safety zone as the principal means of mitigation. Mitigation measures discussed in the Cabrillo Port Environmental Assessment (EA), and in the response to comments (MMS-25) from MMS USCG Review Matrix Supplement February 2004 Final (located in the Supplemental Technical Document, February 2004) would be utilized as necessary to mitigate for project noise levels, as follows:

If an Incidental Harassment Authorization (IHA) is necessary, then a marine mammal monitoring and mitigation program will be established. To avoid take of marine mammals or sea turtles, monitoring should be conducted during the pipeline-laying phase of construction and other phases of construction. In addition to the components of the mitigation described on page 5-60 of the EA, the following components should also be included when monitoring for marine mammals/turtles:

- Construction will be timed to avoid the grey whale migration season.
- A minimum of two NOAA Fisheries-approved observers shall survey the construction area on the lay vessel before and during construction. The observers should work in shifts of four hours. If work is to be conducted on a 24-hour basis, then monitoring should be conducted for a minimum of 75 percent of the time, with on-call observers (possibly an additional two onboard) ready to relieve the working observers at any given time. These observers shall be trained to recognize marine mammals and marine turtles (including their behavior) that are likely to be present in the project area. The observers should be given adequate equipment to effectively observe marine mammals/turtles. Examples include binoculars during daylight hours, and night-time infrared scopes for night-time hours.
- A safety zone of 1,000 ft will be established around construction activities. If a marine mammal/turtle enters or appears likely to enter the safety zone before construction activities begin, then construction should cease or be delayed until the marine mammal/turtle exits the safety zone. If the animal is seen at the surface and the dives, construction activities shall be delayed for 15 minutes to allow time for the animal to exit the safety zone. If a marine mammal/turtle enters the safety zone during construction activities, the observer shall closely monitor and record the animal's behavior. If it appears that the animal is at risk of injury, then construction activities, to the extent possible, will cease until the animal can safely exit the safety zone.

#### **4.2 Onshore Component Impacts**

The typical construction right-of-way will be from 45 to 250 feet and will vary in exact location dependant upon the space available along the paved roadways. Along roadways, construction activities will take place within the roadway and road shoulder. No new permanent access roads are anticipated. Construction is expected to commence in the third quarter of 2007, and would last approximately eight months. It is expected that both pipeline segments will be constructed concurrently. Horizontal directional drilling (HDD) and use of existing pipe bridges may be required at water crossings along the Project routes and most road crossings will be completed by excavation.

Pipeline construction will typically proceed at 300 to 500 feet per day. It is anticipated that both pipelines would be constructed concurrently. The final four weeks of the construction period will be used for testing and final tie-in of the line. Project construction will occur six days per week from 7:00 a.m. to 7:00 p.m. Monday through Saturday. A construction workforce of approximately 100 to 120 personnel for each pipeline will be employed on the Project during the peak construction period. In addition to the construction workforce, biological and cultural resource monitors and other compliance monitors will also be on-site at all times during construction.

Project construction is anticipated to be conducted using one to two main construction "spreads" for each pipeline. The pipeline construction spread will be composed of several units. The units will be organized to proceed with the work in the following general order: pre-construction activities; surveying and staking; right-of-way clearing or pavement cutting; ditching; hauling and stringing the line pipe; pipe bending, lowering in, line up and welding; weld inspection; applying protective coating to the weld joints; backfilling; hydrostatic testing and cleaning; and right-of-way cleanup, paving and restoration.

Construction of the pipeline within the existing paved roads will require the temporary closure of at least one lane or two lanes in accordance with the traffic control plans during the construction phase. Appropriate warning signs will be placed at strategic locations to warn drivers of the closed lanes. Flagmen may also be used at especially busy intersections or roadways. Traffic control plans will be prepared for the Project and requirements from the affected municipalities will be followed. Since construction will occur primarily along existing paved roadways, minimal grading is proposed. No construction of bridges or stabilization of soil to support heavy equipment is anticipated. Construction of temporary access roads, work strip and temporary diversion of streams will be required along pipeline construction within unpaved portions of the route. Fugitive dust emissions at the construction site during earthmoving operations will be controlled by water trucks equipped with fine spray nozzles. Approximately 30,000 gallons of water will be used each day for dust suppression for each pipeline.

Construction procedures for the mainline block valves, metering station, and the modifications to the valve stations will be similar to those proposed for the pipelines, including trenching and welding. No nighttime lighting equipment is anticipated, and noise levels and duration are expected to be the same as those for pipeline construction.

Water course crossings will be accomplished by several techniques, include: open girder bridge, closed girder bridge, open cut trench, and horizontal direction drilling. The proposed pipelines will cross several primary roadways, as well as State Highway 1 and U.S. Highway 101 at the southern portion of the route, and railroad tracks. Road crossings will be done by horizontal boring with a permanent casing. Once traffic control measures are in place, boring operations would begin. Road crossings are completed in accordance with the municipality's requirements and require a work period of 1 to 3 weeks. In general, horizontal boring requires that a permanent casing is installed beneath the roadway, highway, or other structure from excavations made outside each border of the affected structure. The permanent casing is larger than the pipeline allowing the pipeline to be inserted into the casing to complete the crossing.

The staging area(s), will be 400 by 400 feet or 400 by 600 feet, and located near as practical to the construction route. Existing roads will be used for all construction-related traffic and equipment mobilization. Along unpaved portions of the routes, temporary access roads and work strips will be required that are typically 80 feet wide. Staging or laydown areas will be

located on private property on previously disturbed land. Pipe, which comprises the majority of Project materials, will be stored at a vendor's coating yard or existing storage yard off-site until it is unloaded along the route. Aggregate, asphalt, sand, and slurry materials will be purchased from and stored by local suppliers off-site until these materials are unloaded along the route. During all phases of construction, refueling and lubrication of construction equipment will occur at the contractors' staging areas or along the construction route.

Most heavy construction equipment will be delivered to the initial point of the spread on lowboy trucks or trailers. Mobile cranes and dump trucks will be driven in from existing local contractors' yards. Construction equipment will be left overnight at the site, at contractor yards, or at other existing storage yards in the area. All construction materials will be transported to the construction spreads by truck on existing roadways. An estimated 400 to 450 truck trips will be required to deliver materials and equipment for each of the pipeline segments.

#### Onshore drilling spread for HDD work

Table 4.1-2 shows the planned equipment types for the onshore HDD drilling activity, their associated reference dBA (ref. 20  $\mu$ PA), the estimated number of devices to be used, and the estimated average engine load. Estimated airborne air noise level in dBA is shown at intervals of 50 feet to 2500 feet, from the reference noise level cited in the literature, and by calculating the sound pressure levels at each specified distance. Estimated worst case results at each distance were tabulated based upon inverse distance law and root mean square calculations as described below.

For human hearing in air, the decibel scale is defined as:

$$\text{dBA} = 10 \log (P_d^2/P_o^2) = 20 \log (P_d/P_o)$$

where: dBA = noise level, decibels (A weighting)

$P_d$  = sound pressure measured or sensed at distance d,  $\text{N/m}^2$

$P_o$  = referenced sound pressure in air,  $20 \times 10^{-6} \text{ N/m}^2$  (20  $\mu$ PA)

At a sufficient distance from the source, the sound pressure is inversely proportional the distance d from the source (Inverse Distance Law):

$$P_d = (\text{constant}) (D_o/D_d)^{-1} = (\text{constant}) (D_o / D_d)$$

where:  $P_d$  = sound pressure measured or sensed at distance d,  $\text{N/m}^2$

$D_d$  = receiver distance from source, feet

$D_o$  = reference distance from source, 50 feet

Noise reductions following the Inverse Distance Law demonstrate a theoretical 6 dBA falloff with each doubling of distance from the source, as shown in Table 4.1-1. However, atmospheric conditions, such as the presence of coastal fog, can attenuate noise at a greater rate.

Sound pressure from multiple sources in one location or sources operating as less than rated power follow the root mean square (RMS) relationship (square root of the sum of squares):

$$\text{Total } P = (P_1^2 + P_2^2 + P_3^2 + P_4^2 + \dots + P_n)^{0.5}$$

where:  $P_n$  = sound pressure from source n at reference distance  $D_o$

n = number of sources

Under the RMS relationship, two identical sound pressure sources operating at the same location produce about 1.4 times the sound energy of a single source. Conversely, a sound pressure source operating at 50% of rated load produces about 0.7 times the sound energy of full load operation. This method is used to account for equipment quantities and loads shown in Table 4.1-2.

Table 4.1-3 shows the planned equipment types for the onshore pipeline trenching and laying activity, their associated reference dBA (ref. 20  $\mu$ PA), the estimated number of devices to be used, and the estimated average engine load. Estimated ambient air noise level in dBA is shown at intervals of 50 feet to 2500 feet, from the reference noise level cited in the literature, and by calculating the sound pressure levels at each specified distance. Estimated worst case results at each distance were tabulated based upon inverse distance law and root mean square calculations as described above. Fifty feet from the source, worst-case noise levels are 102 dBA, decreasing to 68 dBA at 2,500 feet from the source.

Table 4.2-1 shows typical construction equipment that would be used for the onshore component construction activities. Airborne noise data were developed only, as underwater noise is not a factor for the onshore component. The pipeline route is predominately through agricultural lands along existing right-of-way (ROW). Additional new ROW will be acquired and developed through agricultural land that does not contain residences or sensitive noise areas. The sensitive noise areas along existing ROW are shown in Table 4.2-2 through Table 4.2-5. As show by the Table 4.2-1, estimated noise level approximates, or does not exceed, average city street traffic. Further, construction noise is temporary, short-term, and passes through the area quickly.

Table 4.1-2 calculates worst-case noise levels for HDD 50 feet from the units, the noise levels are 102 dBA, decreasing to 68 dBA at 2,500 feet away. No noise-sensitive receptors are located within this zone, and as such the impact is less-than-significant.

#### **4.2.1 Minimization and Mitigation Measures**

The construction of the pipeline would cause temporary increases in the ambient sound environment in the immediate vicinity of the construction sites. These construction activities would be performed in full compliance with local noise requirements, including limiting construction activities to daylight hours as allowed by the noise ordinances listed above. Nighttime noise levels would be normally unaffected by construction activities, as most construction is typically restricted to daylight hours. An exception to this is HDD operations, which are typically performed on a continuous, around-the-clock operation until completed.

Construction of the pipeline will increase noise levels in the vicinity of the construction activities, but no noise sensitive areas will be affected by operation of the Project. Construction of the Project will be temporary and of short duration. Construction will be limited from 7 a.m. to 7 p.m. with the exception of HDD.

HDD will generate relatively high noise levels, and HDD will occur 24 hours per day until completed. With the exception of HDD operations, pipeline construction-related noise will not exceed applicable local standards and; therefore, would be less than significant. No noise-sensitive receptors are located within 2,500 feet of the HDD location. As such, HDD operations will comply with applicable local noise standards.

As required by the local noise ordinances listed above, all stationary and mobile construction equipment engines must be equipped with suitable exhaust and air-intake mufflers in proper working order. In addition, the construction contractor must inspect and upgrade, when necessary, the mufflers on construction equipment engines. [If the noise from HDD causes nuisance conditions, enclosures or other noise reduction measures are available to further reduce the transmitted noise.](#)

**Table 4.1-1 Construction Noise from Offshore Marine Spread for the Pipelines – Underwater**

Equipment Type	Reference dB	Number of Devices	Average Load	Estimated Noise Level, dB ref, 1 $\mu$ PA (RMS)					
				1 m	10 m	100 m	1 km	5 km	10 km
Small Drilling Rig (offshore)	174	1	40%	170	150	130	110	96	90
Exit Hole Barge Tug	171	1	20%	164	144	124	104	90	84
Supply Boat	181	1	20%	174	154	134	114	100	94
Lorelay Pipe Ship	172	1	100%	172	152	132	112	98	92
Supply Boat	181	1	35%	176	156	136	116	102	96
Large Crane (100 ton)	156	1	50%	153	133	113	93	79	73
Small Crane (35 ton)	156	1	50%	153	133	113	93	79	73
Tugboats	171	2	20%	167	147	127	107	93	87
Survey Vessel	159	1	35%	154	134	114	94	80	74
Helicopter	162	1	100%	162	142	122	102	88	82
<b>Worst Case Results (RMS)</b>				<b>180</b>	<b>160</b>	<b>140</b>	<b>120</b>	<b>106</b>	<b>100</b>

References

- 1) Malme, C. I., P.I. Miles, et al. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior – Phase 2. MMS, Anchorage, AK. NTIS-PB-86-218377.
- 2) Simmonds, M., S. Dolman, and L. Weilgart, eds. 2003. Oceans of noise. A WDCS Science report., Chapter 3 Sources of marine noise. Whale and Dolphin Conservation Society (WDCS), United Kingdom, May 2003. Available at <http://www.wdcs.org>
- 3) NOAA. 2002. Understanding Ocean Acoustics. Acoustic Monitoring Project, NOAA Pacific Marine Environmental Laboratory. <http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html>
- 4) U.S. Navy. Principals of Underwater Sound., <http://www.fas.org/man/dod-101/navy/docs/fun/part08.htm>

**Table 4.1-2 Construction Noise from Horizontal Directional Drilling Activities**

Equipment Type	Reference dBA	Number of Devices	Average Load	Estimated Noise Level, dBA (RMS)					
				50 ft.	100 ft.	250 ft.	500 ft.	1000 ft.	2500 ft.
Horizontal Boring Rig	100	1	80%	99	93	85	79	73	65
Large Drilling Rig (HDD)	100	1	80%	99	93	85	79	73	65
Mud Cleaner Generator	72	1	80%	71	65	57	51	45	37
Mud Pumps	70	2	80%	72	66	58	52	46	38
Fluid Handling Pumps	70	4	80%	75	69	61	55	49	41
Track Backhoe	85	1	50%	82	76	68	62	56	48
All Terrain Forklift	85	1	50%	82	76	68	62	56	48
Light Towers	72	6	100%	80	74	66	60	54	46
Heavy Lift Crane	85	1	50%	82	76	68	62	56	48
18 Wheeler Truck	85	1	50%	82	76	68	62	56	48
<b>Worst Case Result</b>				<b>102</b>	<b>96</b>	<b>88</b>	<b>82</b>	<b>76</b>	<b>68</b>

References

- 1) U.S. Environmental Protection Agency. 1971. Noise from Construction Equipment and Operations, US Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, D.C.
- 2) Plog, Barbara A., Ed. 1988. Fundamentals of Industrial Hygiene 3rd Edition. National Safety Council, Table 9-b, page 168.
- 3) Bruel & Kjaer, 1971, Acoustic Noise Measurements, Figure 2-10, page 20

**Table 4.1-3 Construction Noise from Trenching Activities**

Equipment Type	Reference dBA	Number of Devices	Average Load	Estimated Noise Level, dBA (RMS)					
				50 ft.	100 ft.	250 ft.	500 ft.	1000 ft.	2500 ft.
Concrete Saw	85	1	50%	82	76	68	62	56	48
Trenching Machine	85	1	80%	84	78	70	64	58	50
Track Backhoe	85	1	80%	84	78	70	64	58	50
Front Loader	85	1	50%	82	76	68	62	56	48
Bulldozer	85	1	50%	82	76	68	62	56	48
Dragline	85	1	50%	82	76	68	62	56	48
Dump Truck	91	1	50%	88	82	74	68	62	54
Water Truck	91	1	50%	88	82	74	68	62	54
Utility Truck	85	1	50%	82	76	68	62	56	48
Heavy Fork Lift	85	1	50%	82	76	68	62	56	48
Lowboy Truck	85	4	50%	88	82	74	68	62	54
Pipe Stringing Truck	85	1	50%	82	76	68	62	56	48
Sideboom Tractor	85	2	50%	85	79	71	65	59	51
Mobile Crane	85	1	50%	82	76	68	62	56	48

Pipe Bending Machine	85	1	50%	82	76	68	62	56	48
Welding Generator	72	2	50%	72	66	58	52	46	38
Utility Generator	72	2	50%	72	66	58	52	46	38
Air Compressor	72	2	50%	72	66	58	52	46	38
Dewatering Pump	70	2	50%	70	64	56	50	44	36
Hydrostatic Test Pump	70	1	50%	67	61	53	47	41	33
Fill Dirt Screener	72	1	50%	69	63	55	49	43	35
Sheepsfoot Compactor	85	1	50%	82	76	68	62	56	48
Vibratory Roller	72	2	50%	72	66	58	52	46	38
Hydraulic Tamper	72	2	50%	72	66	58	52	46	38
Cement Truck	91	1	50%	88	82	74	68	62	54
Cement Pump	70	1	50%	67	61	53	47	41	33
Asphalt Truck	91	1	50%	88	82	74	68	62	54
Asphalt Paving Machine	85	1	50%	82	76	68	62	56	48
Asphalt Roller	85	1	50%	82	76	68	62	56	48
<b>Worst Case Result</b>				<b>98</b>	<b>92</b>	<b>84</b>	<b>78</b>	<b>72</b>	<b>64</b>

#### References

- 1) U.S. Environmental Protection Agency. 1971. Noise from Construction Equipment and Operations, US Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, D.C.
- 2) Plog, Barbara A. , Ed. 1988. Fundamentals of Industrial Hygiene 3rd Edition. National Safety Council, Table 9-b, page 168.
- 3) Bruel & Kjaer, 1971, Acoustic Noise Measurements, Figure 2-10, page 20

**Table 4.1-4 Construction Noise from Offshore Marine Spread for the FSRU, Mooring and Riser Systems – Underwater**

Equipment Type	Reference DB	Number of Devices	Average Load	Estimated Noise Level, dB ref, 1 $\mu$ PA (RMS)					
				1 m	10 m	100 m	1 km	5 km	10 km
AHTS	181	2	35%	179	159	139	119	105	99
Work Boat	159	1	35%	154	134	114	94	80	74
Tugboats	171	2	20%	167	147	127	107	93	87
Survey Vessel	159	1	35%	154	134	114	94	80	74
Helicopter	162	1	100%	162	142	122	102	88	82
<b>Worst Case Results (RMS)</b>				<b>180</b>	<b>160</b>	<b>140</b>	<b>120</b>	<b>106</b>	<b>100</b>

#### References

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- 3) NOAA. 2002. Understanding Ocean Acoustics. Acoustic Monitoring Project, NOAA Pacific Marine Environmental Laboratory. <http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html>
- 4) US Navy. Principals of Underwater Sound, <http://www.fas.org/man/dod-101/navy/docs/fun/part08.htm>

**Table 4.1-5 Construction Noise from Helicopters and Marine Vessels for Logistics Support**

Equipment Type	Reference	Estimated Noise Level, dB ref, 1 $\mu$ PA (RMS)					
		1 m	10 m	100 m	1 km	5 km	10 km
16 ft. Zodiac (rescue craft)	2,3,4	156	136	116	96	82	76
23 ft. Outboard Motor Boat	1,3,4	156	136	116	96	82	76
Tugboat & Loaded Barge (10 knots)	2,3,4	171	151	131	111	97	91
110 ft. Diesel Workboat	1,3,4	159	139	119	99	85	79
Drilling Rig	2,3,4	174	154	134	114	100	94
Supply Ship (AHTS)	2,3,4	181	161	141	121	107	101
Pipelay Ship	2,3,4	172	152	132	112	98	92
Helicopter flyover (minimum alt.)	2,3,4	162	142	122	102	88	82

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- 1) Malme, C. I., P.I. Miles, et al. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior – Phase 2. MMS, Anchorage, AK. NTIS-PB-86-218377
- 2) Simmonds, M., S. Dolman, and L. Weilgart, eds. 2003. Oceans of noise. A WDCS Science report., Chapter 3 Sources of marine noise. Whale and Dolphin Conservation Society (WDCS), United Kingdom, May 2003. Available at <http://www.wdcs.org>
- 3) NOAA. 2002. Understanding Ocean Acoustics. Acoustic Monitoring Project, NOAA Pacific Marine Environmental Laboratory. <http://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html>
- 4) U.S. Navy. Principals of Underwater Sound, <http://www.fas.org/man/dod-101/navy/docs/fun/part08.htm>

**Table 4.2-1 Construction Noise from Onshore Component**

Construction Equipment	Reference	Estimated Noise Level, dBA					
		50 ft.	100 ft.	250 ft.	500 ft.	1000 ft.	50 ft.
Dump Truck	1	91	85	77	71	65	57
Backhoe	1	85	79	71	65	59	51
Drilling Equipment Diesel Engines	2	100	94	86	80	74	66
Flatbed Truck	1	85	79	71	65	59	51
Pickup Truck	1	70	64	56	50	44	36
Tractor Trailer	1	85	79	71	65	59	51
Crane	1	85	79	71	65	59	51
Pumps	1	70	64	56	50	44	36
Welding Machine	1	72	66	58	52	46	38
<i>City Street Traffic</i>	3	80	74	66	60	54	46

References

- 1) U.S. Environmental Protection Agency. 1971. Noise from Construction Equipment and Operations, US Building Equipment, and Home Appliances. Prepared by Bolt Beranek and Newman for USEPA Office of Noise Abatement and Control, Washington, D.C.
- 2) Plog, Barbara A., Ed. 1988. Fundamentals of Industrial Hygiene 3rd Edition. National Safety Council, Table 9-b, page 168.
- 3) Bruel & Kjaer, 1971, Acoustic Noise Measurements, Figure 2-10, page 20.

**Table 4.2-2 High Consequence Area Sites along the Center Road Pipeline Route**

<b>Sites</b>	<b>Address</b>	<b>Mile Post</b>	<b>0-300</b>	<b>&gt;300 - 660</b>	<b>&gt;660 - 1000</b>	<b>&gt;1000 - 1320</b>
Mesa Union Junior High School	No address available (Camarillo, CA)	13.6			X	

**Table 4.2.3 High Consequence Area Sites along the Center Road Pipeline Alternative Route 1A**

<b>Sites</b>	<b>Address</b>	<b>Mile Post</b>	<b>0-300</b>	<b>&gt;300 - 660</b>	<b>&gt;660 - 1000</b>	<b>&gt;1000 - 1320</b>
Calvary Baptist Church	950 E Pleasant Valley Rd, Oxnard, CA	1.9		X		
Morla Residential Care Home	934 Berkshire Place Oxnard, CA	1.9		X		
Ocean View Children's Center (Ocean View Early Education School)	5201 Squares Dr. Oxnard, CA	1.9			X	
Fred E. Williams Elementary	4300 Anchorage, Oxnard, CA	2.2			X	
Oxnard Community College	4000 S. Rose Ave Oxnard, CA	2.8	X			
Tierra Vista Elementary School	2001 Sanford St. Oxnard, CA 93033	2.9				X
Mar Vista Elementary School	2382 Etting Road Oxnard, CA	3.0			X	
Mesa Union Junior High School	No address available (Camarillo, CA)	12.0			X	

**Table 4.2-4 High Consequence Area Sites along the Center Road Pipeline Alternative Route 1B**

<b>Sites</b>	<b>Address</b>	<b>Mile Post</b>	<b>0-300</b>	<b>&gt;300 - 660</b>	<b>&gt;660 - 1000</b>	<b>&gt;1000 - 1320</b>
Calvary Baptist Church	950 E Pleasant Valley Rd, Oxnard, CA	1.9		X		
Morla Residential Care Home	934 Berkshire Place Oxnard, CA	1.9		X		
Ocean View Children's Center (Ocean View Early Education School)	5201 Squares Dr. Oxnard, CA	1.9			X	
Fred E. Williams Elementary	4300 Anchorage, Oxnard, CA	2.2			X	
Oxnard Community College	4000 S. Rose Ave Oxnard, CA	2.8	X			
Tierra Vista Elementary School	2001 Sanford St. Oxnard, CA 93033	2.9				X
Mar Vista Elementary School	2382 Etting Road Oxnard, CA	3.0			X	
Mesa Union Junior High School	No address available (Camarillo, CA)	12.3			X	

**Table 4.2-5 High Consequence Area Sites along the Center Road Pipeline Alternative 2 Route**

<b>Sites</b>	<b>Address</b>	<b>Mile Post</b>	<b>0-300</b>	<b>&gt;300 - 660</b>	<b>&gt;660 - 1000</b>	<b>&gt;1000 - 1320</b>
Calvary Baptist Church	950 E Pleasant Valley Rd, Oxnard, CA	1.9		X		
Morla Residential Care Home	934 Berkshire Place Oxnard, CA	1.9		X		
Ocean View Children's Center (Ocean View Early Education School)	5201 Squares Dr. Oxnard, CA	1.9			X	
Fred E. Williams Elementary	4300 Anchorage, Oxnard, CA	2.2			X	
Oxnard Community College	4000 S. Rose Ave Oxnard, CA	2.8	X			
Tierra Vista Elementary School	2001 Sanford St. Oxnard, CA 93033	2.9				X
Mar Vista Elementary School	2382 Etting Road Oxnard, CA	3.0			X	
Channel Islands Surgicenter	2300 Wankel Way, Oxnard, CA	7.1			X	
Peppermint Junction	2150 E Gonzales Rd, Oxnard, CA	7.1	X			
Channel Islands Vineyard Church	1851 Holser Walk #200 Oxnard, CA	7.8		X		
Neurosciences Institute	1600 N Rose Ave, Oxnard, CA	7.9			X	
St. Johns Medical Center	1600 N Rose Ave, Oxnard, CA	8.0	X			
Tried Stone Church Of God	1350 E. Channel Islands Blvd. Oxnard, CA	8.2			X	
Santa Clara Chapel	1333 E Ventura Blvd, Oxnard, CA	8.4			X	
Rio Real Elementary School	1140 Kenney St., Oxnard, CA	8.5		X		

## 5.0 References

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## **Appendix A – Offshore Sequence Schedule**







